Appendix D: The Hub and Spoke System

Whatcom Transportation Authority
2017 Strategic Plan

Nelson\Nygaard Consulting Associates, Inc.

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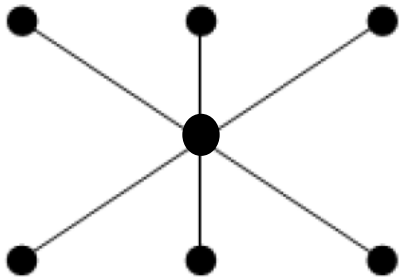
IS "HUB AND SPOKE" THE BEST DESIGN FOR WTA?

What is Hub and Spoke?

Hub and Spoke, sometimes also called "radial," is a description of a generalized design for a transportation system—in this case, a fixed-route transit system. The essential design provides for routes (the spokes) that all converge on a single point (the hub). Riders wishing to reach different points on the various spokes all travel through the hub. Although the hub is often located in a major activity center like a downtown, e.g. Bellingham Station, where many people are already within walking distance of their final destination and do not need to transfer to one of the other spokes to reach their final destination.

The diagram below is a highly schematic depiction of the hub and spoke concept. This design is best applied where there is a major activity center that is surrounded by smaller activity centers or often, as is the case with WTA, there are multiple hubs, like Bellingham Station, Cordata Station, and WWU.



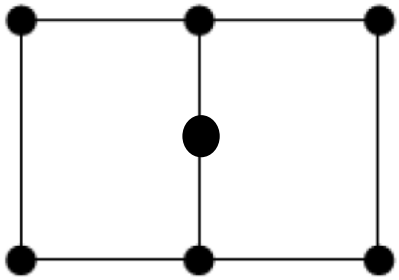
The advantage of this design is that it offers the most efficient way of connecting activity centers where the surrounding area generates less travel activity compared to the hub. The efficiency of this network design is readily observed in the airline industry, where every major domestic airline operates on a multi hub and spoke design.

Note that in the diagram above, there are only six line segments necessary to connect each node through the hub. Think of these as routes. The disadvantage is that riders wanting to travel between outer nodes often have to travel to the center, then back out on another spoke to reach their destination. This often means a long bus ride to reach a fairly adjacent location. In transit systems based on the hub and spoke model, routes serving the hub are often orchestrated in a pulse, where all the routes are designed and scheduled to arrive and leave the hub at the same time—thus facilitating transfers and making travel in the network somewhat more efficient. This is the essential design of the WTA system, although it has been adapted to accommodate high ridership levels at WWU during the school year.

What Are Other Basic Design Options?

There are two other basic design options, Grid and Point to Point. A grid system is much like a typical city street system. The parts of the city are interconnected by a grid of routes. For transit, this often means operating routes on a spacing interval (usually one mile or half a mile). In designing a bus transit system, the other necessary ingredient is serving a city that has a street system that follows a grid pattern fairly un-interrupted by barriers. This design is often applied to prairie cities where the grid pattern of the streets is well defined. The diagram below is a highly

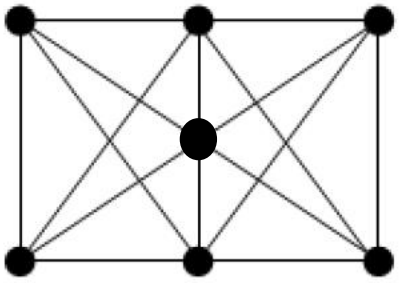
schematic depiction of the grid concept. Note that a rider may need to transfer at least once just to reach the center of the network from one of the corner nodes. These networks work very well when there is a relatively dense core of the city in terms of activity levels.



Think of an area of at least four miles by four miles with uniform and moderate-to-high levels of activity. At minimum, the level of activity would likely include four-to-five story apartments with ground floor retail, intermixed with schools, offices, and larger retail like department stores or grocery stores. This level of activity is necessary to allow the grid to productively operate at a high level of frequency, as the grid depends heavily on frequent service (15 minutes or less) on each part to facilitate transfers.

Note that compared to the hub and spoke model the grid requires eight line segments or routes to interconnect all parts of the network. Frequency aside, this means the grid design requires one-third more resources simply to inter-connect the network. When frequency is accounted for, this could mean even more resources to make the network functional. Grid networks are not good candidates for pulse-type scheduling, as routes would need to provide timed transfers at a minimum of two nodes to accomplish that objective. That would mean each route would need nearly identical operating characteristics, such as distance and speed, to accomplish a pulse at every node in an efficient manner. In practice, this rarely occurs.

The other common transit system design option is a point to point network design. In this case, every point is connected to all other points in the network. A rider located along any point of any route between points can simply board a bus and reach another place in the network. The diagram below is a highly schematic depiction of the point to point concept.



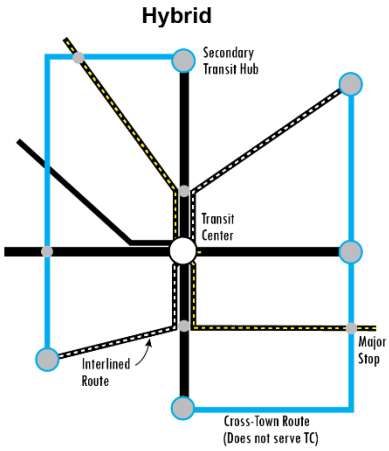
The advantage to the rider is readily apparent—a trip began at any node can reach any other node without a transfer. However, this level of mobility comes at a high price compared to the hub and spoke concept; connecting this network requires 20 line segments, more than three times the number of segments required for the hub and spoke system design. If all routes were operating at an equivalent frequency, the point to point network is far more expensive to operate, but great for

the riders. Transfers are minimized as is travel time between various nodes. This design is often applied to express bus systems, or where the activity levels at each node are very similar.

For example, if the WWU campus, Downtown Bellingham, Cordata Station, Bellis Fair Mall, Barkley Village, Sunset Square, St. Joseph Hospital, Fairhaven, and the airport all operated at the same level of activity, a design like this would be very expensive, but offer a substantial improvement in mobility compared to a hub and spoke design while retaining a respectable level of productivity. Today, however, the activity levels at these centers are not the same, nor do the resources exist to operate a fully functional point to point network design within Bellingham.

How Has the WTA Network Adapted?

Today's network of services is a hybrid of a hub and spoke system and a point to point network. See the diagram below for an example of a hybrid network. The hubs are WWU, Bellingham Station, Cordata Station, and Fairhaven. There are frequent point to point services directly connecting most of these hubs with some notable exceptions, like Cordata to WWU. Although, this trip is available without a transfer, it still travels through the downtown hub. One of the challenges for WTA is that the most active hub in Bellingham, WWU, is not active during all time periods. This means the network has to be adaptable to very high and very low periods of demand from this major node. If not, WTA would be operating with substantial surplus capacity during summer months.



Comparatively speaking, transit in Bellingham has evolved considerably and can be expected to evolve more as resources become available, travel habits evolve, and the community continues to grow and change. In the forthcoming years, it may become possible for a transit rider who resides in Barkley Village to reach the airport, St. Joseph's Hospital, or Bellingham Technical College—or maybe all three locations—without first having to make their way to downtown Bellingham or Cordata Station. Such changes are forecast for the mid-term to longer-term for WTA. However, they will be balanced with considerations like available resources, demonstrated demand, and balancing needs across the entire system.

In conclusion, WTA's fixed-route service is a hybridized hub and spoke transit design that has adapted to serve current community activity centers and is aligned with community values in terms of affordability. The only surety for the future is that it will continue to evolve as usage patterns and community support for transit change.